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# The Environmental Protection Agency

## Introduction

In everything you do, your goal is to maximize society's well-being. This means producing the greatest net social benefit (net social benefit = gross social benefit – social cost). To keep this exercise simple, the gross social benefit is the same as the profits earned by Alpha Electricity and Beta Industries.

## Data on Emissions and Benefits of CO<sub>2</sub> Emissions

You do not know the social benefit of Alpha's and Beta's emissions, but your engineers estimate that for the average factory or power plant emitting 5 million tons of CO<sub>2</sub>, the marginal social benefit of emissions is likely to be somewhere in the range of \$40-\$120 million.

You have a better handle on the social cost and your crack staff of environmental scientists and economists has put together table 1, which shows the social cost of emissions. If you do nothing, each company will emit 15 million tons, for a total of 30 million tons.

## Your Job

You will need to find a way to motivate firms to limit air pollution to the efficient level.

- You will start by asking firms about their marginal profits from emissions for three different amounts of emissions (bearing in mind that they may not be entirely truthful in their responses).
- Once you have come up with your best guess of the marginal profits, you can determine the optimal level of emissions.
- With this number in mind, you will need to determine:
  1. A uniform emissions standard that you would apply to all firms under a command-and-control framework.
  2. The number of permits you would issue under a cap-and-trade framework. (Each permit allows a firm to emit 1 million tons of CO<sub>2</sub>.)
  3. The tax you would impose (dollars per ton) under an emissions-tax framework.

You want to balance the economic benefits of profitable industries against the social costs of climate change, so when you are devising pollution-control strategies, you would like to achieve the optimum level of emissions while allowing the companies to earn the largest possible profits.

Hint: What is the relationship between marginal profits and marginal social costs at the optimal level of emissions?

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CO <sub>2</sub> Emissions (Millions of Tons)	Marginal Social Cost (Millions)	Total Social Cost (Millions)
0	—	0
1	2	2
2	4	6
3	6	12
4	8	20
5	10	30
6	12	42
7	14	56
8	16	72
9	18	90
10	20	110
11	22	132
12	24	156
13	26	182
14	28	210
15	30	240
16	32	272
17	34	306
18	36	342
19	38	380
20	40	420
21	42	462
22	44	506
23	46	552
24	48	600
25	50	650
26	52	702
27	54	756
28	56	812
29	58	870
30	60	930

**Table 1: Social cost of CO<sub>2</sub> emissions. Emissions listed here refer to the combined emissions of both companies.**

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## Worksheet

This worksheet is to help you keep track of what you did in the lab. You do not need to turn it in.

1. Ask Alpha and Beta about their marginal profits at three different emissions levels. Record the questions you ask and the answers you receive.

Question	Emissions	Marginal Profit
1		
2		
3		

2. Use either RStudio or the web app at [https://ees3310.jgilligan.org/emissions\\_trading/](https://ees3310.jgilligan.org/emissions_trading/) to estimate the marginal profit, and fill in table 2 on page 6:

- (a) First, go to the “Marginal Profit” tab on the web app and enter the answers you received from Alpha and Beta. If you do not trust the company’s answer, you may enter your best guess for its actual profit.
- (b) After you have entered marginal profits for Alpha and Beta, the app will calculate the average marginal profit at each of the three emissions levels.
- (c) After you have entered the marginal profits for all three emissions levels, the web app will estimate the average marginal profit for the blank rows in the table.
- (d) The app lets you choose whether you want the table to use the exact values you entered for the marginal profits at the three emissions levels, or if you want it to replace those with the values for a linear fit to the data points. **This is your choice.**
- (e) Fill in Table 2 on your worksheet from the table on the web app.

3. Work out the optimum level of emissions:

- a) Go to the “Optimum Emissions” tab on the web app. This tab has a table with four columns:
  - **Total Emissions** is the total emissions from Alpha and Beta.
  - **Marginal Social Cost** is the marginal social cost for that emissions level.
  - **Company Emissions** is the average emissions for each company. Because there are two companies, this is half of the **total emissions** column because the total emissions must be the sum of each company’s emissions.
  - **Marginal Profit** is the average marginal profit for each company at this emissions level. This comes from the table on the “Marginal Profit” tab.
- b) Find the row of the table where the **average marginal profit** is closest to the **marginal social cost**. Copy this row and a few rows above and below into table 3 on your worksheet.
- c) Write this marginal profit and the corresponding “**company emissions**” in table 3 (Optimum Emissions), on page 6.
- d) Your emissions target is the total emissions for which the **marginal social cost** is closest to the **marginal profit**.

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What are your targets for emissions and marginal social cost?

4. Under command-and-control, you would allow each company to emit the corresponding **company emissions**, which is half of the total target emissions. **How much is this?**
  
5. Under a cap-and-trade program, **how many permits to emit pollution would you issue?** Each permit allows the holder to emit 1 million tons of CO<sub>2</sub>.

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6. Under an emissions-tax program, how much would you tax emissions (dollars per ton of CO<sub>2</sub>)?

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Company Emissions (Million Tons)	Marginal Profit (\$ million)		
	Alpha	Beta	Average
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

**Table 2: Table for estimating the average marginal profit**

Total Emissions	Marginal Social Cost	Company emissions (half the total)	Marginal Profit

**Table 3: Table for calculating the optimum emissions**